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Characterization of Sorbed Uranium(VI) on Monosodium Titanate

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Introduction: The current proposed design for the Salt Processing Facility at the Savannah River Site include use of monosodium titanate (MST) to remove radiostrontium and selected actinides from the High Level Waste (HLW) solutions. There are many mechanisms of metal uptake by surfaces. Information on the primary mechanism for actinide uptake by MST will provide insight about whether MST will be a reliable performer in HLW treatment. Little is known about the structure of MST but it most likely contains Ti^{4+} octahedra as opposed to tetrahedral Ti^{4+} . Moreover it is not known why MST has an affinity for U in alkaline (pH 14) HLW simulant solutions that are rich in Na^+ ion.

Methods and Materials: To study the chemistry of sorbed U on MST in HLW salt simulant solutions we used X-ray absorption fine structure spectroscopy (XAFS) and molecular modeling techniques. Uranium-loaded MST solids were prepared in HLW salt simulant solutions to have U loadings ranging between 3000 and 12,500 mg U kg^{-1} MST. Data collection was conducted at the L_3 absorption edge of U (17.166 keV) using a Lytle detector.

Results: The analyses indicate that the sorbed U is present as monomeric and dimeric U(VI) species with a split first shell containing axial and equatorial U-O interactions. Uranium-C (or N), U-Ti, and U-U interactions were also observed. From these data, we conclude that the U(VI) sorbs via an inner sphere/specific adsorption mechanism. The sorbed U exists as mono-, di- and tri- carbonato or nitrato complexes that sorb via bidentate linkages on the MST. The sorption behavior varied to a limited extent with the degree of loading with monomeric U species predominating at low loadings and dimeric U species favored at high loadings. WSRC-MS-2001-00728.